Programmatics

Mark Johnson

Program Manager

NRL

202-404-5328

**johnson@ssdd.nrl.navy.mil**

Agenda

- **Organizational Charts**

- **System Elements**

- **Contract Status (Key)**

- **Communication**

- **Risk Management**

- **Documentation**

- **Schedule**

Organization Chart


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                        NASA HQ
                        Code S

                        GSFC
                        MIDEX Office

Senior Executive Board        Principal Investigator
USNO, NRL, SAO                 Dr. K. Johnston
& LMMS ATC                     USNO

Education                                         Science Team
and Public Outreach                               Dr. K. Seidelmann, Chair
Coordinator                                       USNO

Systems Engineering           Project Manager     Project Scientist
and Integration Team          Mr. M. Johnson      Dr. D. Monet
NRL/LMMS/USNO                  NRL                 USNO

Systems Engineering
NRL

Mission Assurance
NRL / LMMS ATC

S/C IPDT Lead                 Instrument IPDT Lead    MO&DA IPDT Lead
Mr. C. Garner                 Dr. R. Vassar           Dr. R. Gaume
NRL                           LMMS ATC                USNO
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Organization Chart (Phase E)


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                    Principal Investigator
                    Dr. K. Johnston (USNO)
                              |
                        MO&DA Manager
                      Dr. R. Gaume (USNO)
                              |
                                    Systems Engineer
                                   Mr. B. Dorland (USNO)
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- **Science Ops Center Mgr** Mr. B. Dorland (USNO)
- **Data Simulator** Dr. J. Pier (USNO-Flag)
- **Data Pipeline Software** Mr. T. Codella (USNO/TB)
- **Input Catalog** Mr. S. Urban (USNO)
- **Postdocs** (3) - Launch (USNO)
- **Mission Ops Center Mgr** Ms. P. Klein (NRL)

Under Science Ops Center Mgr:
- DI, AR, QL Processes Dr. E Malaret (ACT)
- SOC Lead Operator
- SOC Data Techs (5)

Under Data Pipeline Software:
- Pipeline Alg Lead Dr. G. Kaplan (USNO)

Under Mission Ops Center Mgr:
- Blossom Point Mgr Mr. D. Glessner (Honeywell)
- Orbit Design Mr. J. Barnds (NRL)
- Orbit Determination Ms. L. Policastri (NRL)
- DSN Mr. S. Waldherr (NASA)

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System Elements Block Diagram
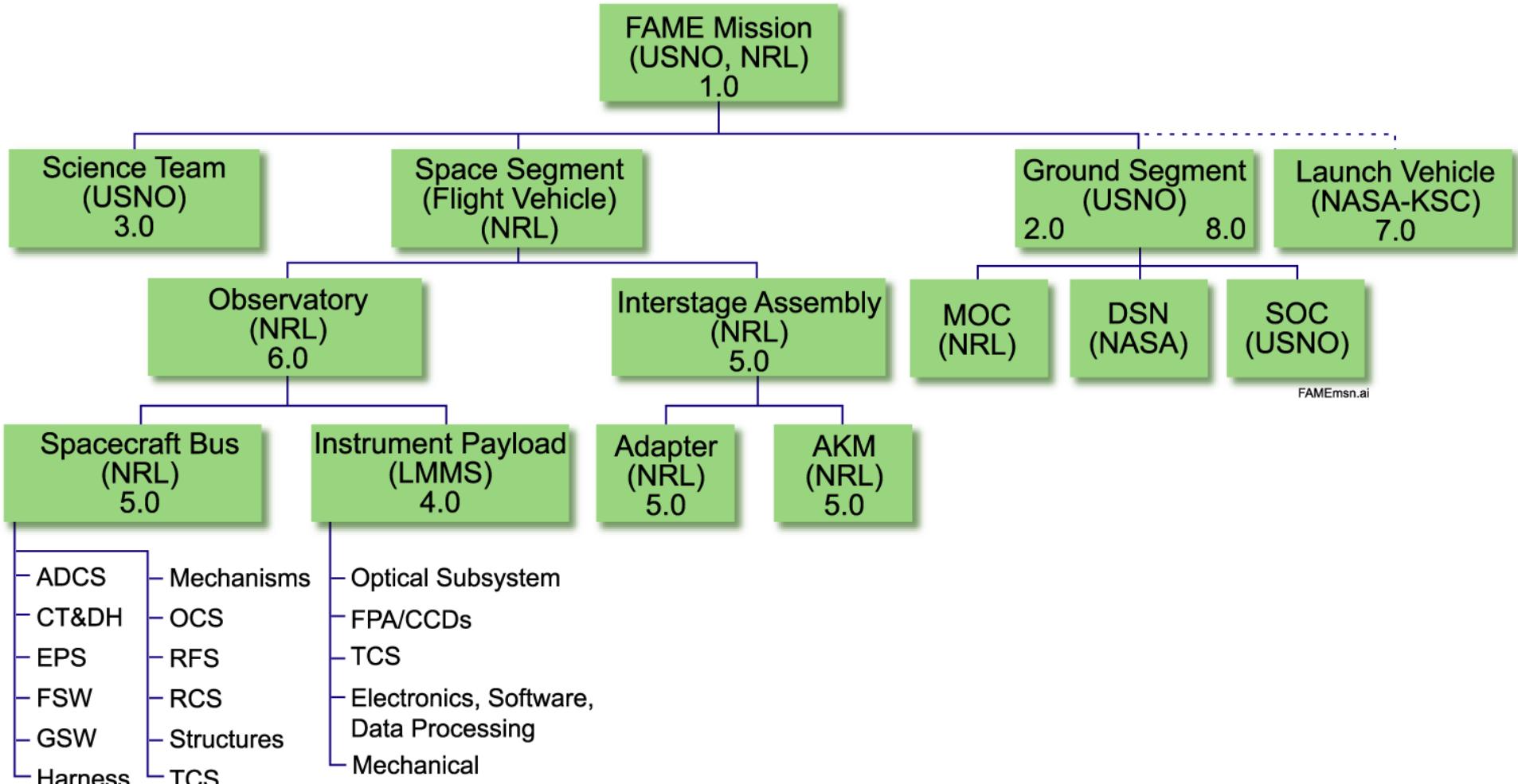
Current Contract Status

- **Lockheed-Martin – ATC**
  - **Contract in Place With NRL - #N00173-00-C-2039 to Design, Fabricate, and Test the FAME Instrument Subsystem**
  - **Contract Award 3/00**
  - **Base Contract Covers Phase B Activities**
  - **Optons for Phase C/D and Phase E**
- **CCDs**
  - **Site (Portland, OR) Under Contract to Lockheed-Martin – ATC to Supply CCDs**
  - **Contract (FFP) Awarded 7/00**
- **Optics**
  - **Goodrich Under Contract With Lockheed-Martin – ATC to Fabricate and Integrate Optical Elements**
  - **Contract Awarded 10/01**
- **Support Contracts**
  - **Praxis, Orbital Sciences, Honeywell, and Assurance Technology Corp. Have Direct Contracts With NRL to Provide Spacecraft Engineering Services**

Communication

- **Open Lines of Communication Key to Program Success**

- **Working Group Meetings – As Required for Technical Issues**
  - **Algorithms, Software, Interfaces, CCDs, Optics, etc.**

- **Weekly Program Telecons – Thursdays 2PM (11 AM)**
  - **Discuss Current Status, Progress, Issues**

- **Monthly Management Meetings**
  - **Cost / Schedule / Technical Progress**

- **Technical Interchange Meetings**
  - **Conducted Every 64-6 Weeks During FY01**
  - **Rotate Locations (Lockheed / NRL)**

- **Science Team Meetings**
  - **Every 6 Months at USNO**

Risk Management Approach

Cost/Schedule Impacts → Program Management → Mitigation

Systems Engineering

Instrument	S/C Bus	MO&DA
Risks	Risks	Risks

Identify Risks (Risk Lists)

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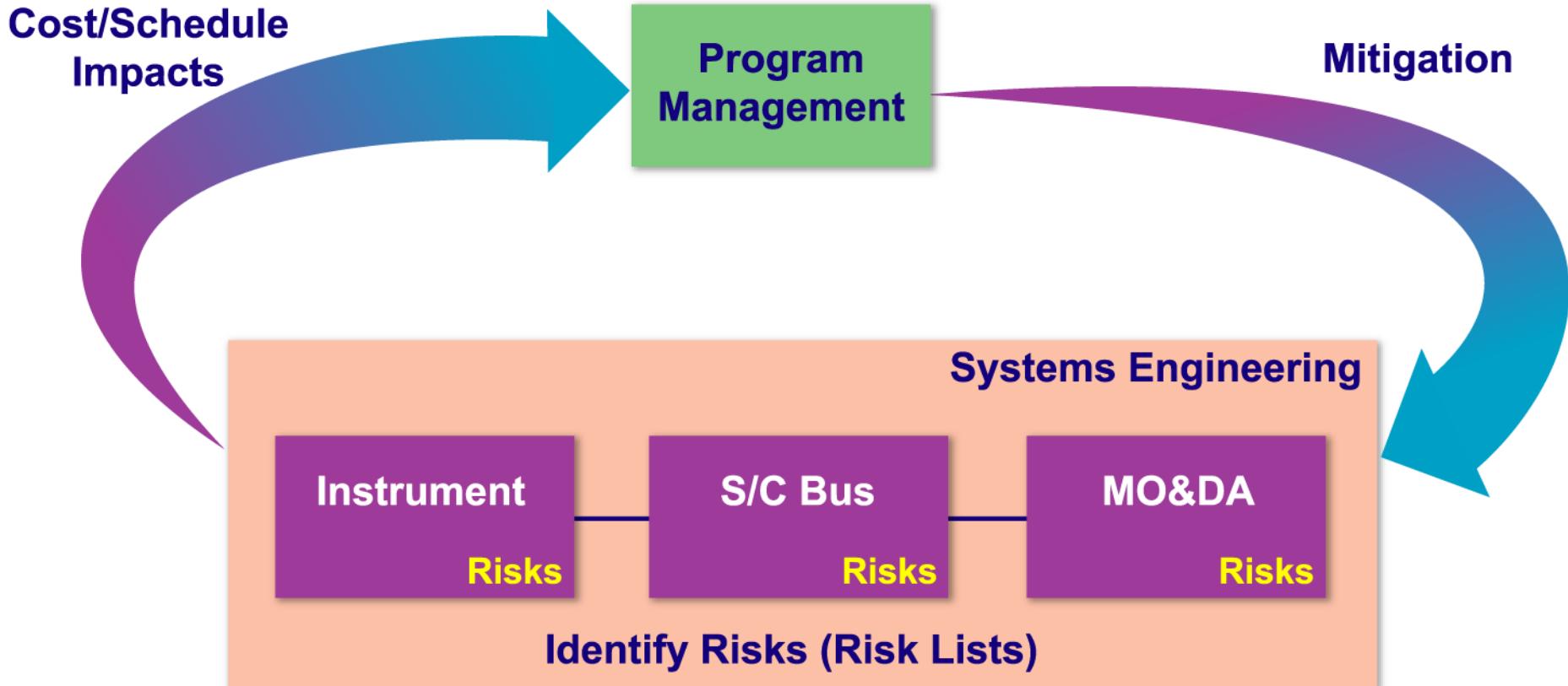
- **Continuous Evaluation, Not Tied to Pre-Set Meetings**

Risk – PDR Mass Margin

- **Issue**
  - **Mass Margin for 7425- 10 ELV Is < 20% at PDR**

- **Mitigation**
  - **Launch on 7925-10 ELV**
    - **Mass Margin on 7925-10 > 20%**

- **Impact**
  - **Utilize Previous 7925-10 FAME S/C Bus Design**
    - **31" Propellant Tank (No Schedule or Cost Impact)**
    - **Star 37 AKM (No Schedule or Cost Impact)**
    - **Complete FEM/Analysis on Structural Design**
      - **Less Than 1 Month Critical Path Impact**
      - **Schedule Recovery by Parallel Development of EM/FM Structural Builds**

No.	Risk Item	Mitigation Plan	Risk		Mitigation Status
			Instr. PDR Status	Observ PDR Status	
I-1	CCD Yield: Low yields from pilot lot, lot 1, and lot 2.	•Evaluate alternate designs to improve yield •Provide LM support to SITe to assist in problem identification and resolution and help them succeed. •Evaluate funding second CCD supplier •Determine if second CCD supplier has an existing compatible design	MEDIUM-HIGH	MEDIUM-HIGH	Selected single-layer metal design with stronger heritage at SITe. LM provided support to SITe via an experienced CCD project manager and a low-noise instrumentation expert. Chose not to fund alternate CCD supplier because second supplier was unable to su
I-2	CCD Delivery: Delivery of 44 flight CCDs is 6 months behind schedule. Less than 1 month schedule slack at the instrument level.	•High rate production capability at SITe because they thin at wafer level •Upgrade EM CCDs to Flight CCDs as required to support schedule •Evaluate funding second CCD supplier •Determine if second CCD supplier has an existing compatible design	MEDIUM	MEDIUM-HIGH	High rate production in use to thin 5 wafers in 2 weeks Chose not to fund alternate CCD supplier because second supplier was unable to support program schedule requirements and due to cost constraints.
I-3	Optical Requirements Flowdown: Instrument optical wavefront requirement of lambda/13.4 RMS may not support observatory requirement to centroid to 1/350 pixel	Investigate tightening or modifying optical wavefront requirement. Evaluate centroiding performance of current optical design using SM data analysis algorithms. Consider narrowing passband of astrometric CCD filters to improve pixel sampling of PSF.	n/a	MEDIUM-HIGH	Discussions underway with Goodrich regarding adding additional optical requirements to control coma and tricore or tightening RMS wavefront requirement. SM data analysis algorithm development has started. Evaluation of PSFs expected by April 2002.

No.	Risk Item	Mitigation Plan	Risk		Mitigation Status
			Instr. PDR Status	Observ PDR Status	
I-4	Instrument to Spacecraft Electronics Interface: Instrument processing moved to spacecraft computer adding interface complexity and defering end-to-end testing. Potential schedule impact during observatory integration and test.	Early and detailed definition of interface. Simplify interface where possible. Early checkout of interface using EM spacecraft flight computer with Instrument DPA, APA, and EM FPA.	n/a	MEDIUM-HIGH	NRL and LM teams working together well. Interface maturing rapidly.
I-5	Compound Mirror Basic Angle Stability: Not meeting 10 micro-arcsecond over 10 minutes basic angle stability requirement	•Evaluate alternate design approaches. •Evaluate relaxing requirement.	MEDIUM	MEDIUM	Descoped instrument design has improved performance (33 μarcsec/10 min vs. 52 μarcsec/10 min for IPDR design) as a result of a solid CMMB and longer baffles. Design sensitivity analysis is in process. •PI is investigating modeling capability and a relaxat
I-6	Optical Stability: Meet lambda/13.4 instrument spec through thermal cycling, launch, transition to zero-g, structure outgassing, and on-orbit thermal variations.	Evaluate optical designs with less alignment sensitivity. Evaluate active secondary mirror mechanism for ground and on-orbit alignment. Verify alignment capability in instrument thermal-vac testing. Validate instrument thermal model during thermal balance	MEDIUM	MEDIUM	Cassegrain design is less sensitive to alignment errors than TMA design. Added 3-axis active secondary mirror mechanism and phase diversity based alignment algorithm using FPA LEDs. •Preliminary OTM modeling shows stable alignment and optical wavefront wi

OPDR Instrument Risk Assessment (3 of 5)

No.	Risk Item	Mitigation Plan	Risk		Mitigation Status
			Instr. PDR Status	Observ PDR Status	
I-7	Electronics: Potential for cross-talk and noise due to high-density FPA and high-level CCD camera control signals and low-level CCD analog readout.	Careful attention to grounding, shielding, and low-noise design practices during board layout. Test breadboard electronics with Evaluation Unit CCDs. Test EM electronics with EM FPA.	MEDIUM	MEDIUM	Designed CCD flex lead for maximum shielding.
I-8	Instrument Delivery to NRL: Planned instrument delivery to NRL is 11/14/03.	LM and Goodrich to evaluate approaches to accelerate optics delivery schedule. Develop a joint approach with NRL to shorten the instrument test span.	HIGH	MEDIUM	Cassegrain design is easier to fabricate. Goodrich will integrate optics onto the instrument structure which shortens the overall instrument schedule. Vibration and EMI testing deferred until after delivery to NRL.
I-9	Negative Stress Margins for Optical Components: Negative margins in compound mirror assembly (CMA) mount/glass interface using NRL secondary structure load curve	•Modify mount design •Replace NRL secondary structure load curve with LM curve •Perform tests on ULE to increase stress allowables	n/a	MEDIUM	Parametric studies underway at Goodrich using PRISM FEMs. Detailed stress analysis of FAME CMA started. Discussion underway between NRL and LM regarding secondary structure curve.
I-10	FPA EMI Susceptability: EMI susceptability of FPA from omni antenna located on the instrument.	Implement good EMI design practices. Consider EMI testing of EM FPA and spacecraft omni antenna. EMI susceptability testing at observatory level. Relocate omni antenna if required.	n/a	MEDIUM	EMI/EMC control plan in place. EMI susceptability testing at instrument level following instrument delivery to NRL. EMI susceptability testing at observatory level.

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No.	Risk Item	Mitigation Plan	Risk		Mitigation Status
			Instr. PDR Status	Observ PDR Status	
I-11	Stray Light Requirements Flowdown: Current instrument straylight exclusion zone of 0.7 steradians may not support number of star observations needed to meet observatory astrometric requirement of 50 μarcsec.	Evaluate performance of current instrument design using spiral reduction simulation. Refine stray light analysis. Investigate design modifications to improve stray light performance.	n/a	MEDIUM	Simulation of current design with straylight exclusion zone is underway. Refined stray light analysis results expected by ICDR.
I-12	Mechanical and Thermal Design of High Density FPA: Mechanical integration and alignment of 24 2Kx4K into high density FPA. Heat dissipation and thermal control via passive radiator.	Early design maturation to surface and resolve issues. Build EM focal plane to evaluate assembly procedures and thermal characteristics.	MEDIUM	MEDIUM-LOW	FPA design issues worked aggressively during Phase B. FPA assembly and CCD alignment issues understood. FPA thermal design mature. 13 CCD FPA simplifies cabling and thermal strapping.
I-13	CCD Radiation Degradation: Proton environment in Geo orbit could produce radiation traps in the CCD which would impact CTE and centroiding	Provide adequate radiation shielding. Evaluate CCD charge injection capability to mitigate radiation damage. Perform pre and post radiation testing on EM CCDs.	MEDIUM-LOW	MEDIUM-LOW	Provide 1 inch equivalent Al shielding for CCDs. FAME CCD design includes charge injection. Accelerate testing by using Evaluation CCDs due to delay in delivery of EM CCDs.
I-14	Contamination: Maintain level 100 on optical surfaces through instrument I&T, observatory I&T, and launch processing	Evaluate contamination control approaches on similar programs. Implement contamination control plan. Flow contamination control requirements to observatory integration.	MEDIUM-LOW	MEDIUM-LOW	Apply LM experience from prior space optical systems (HST, SIRTF, SXI) with similar reqmts. Completed contamination analysis. Flowed requirements to optics and structure specifications. NRL aware of requirements for handling instrument following delivery.

No.	Risk Item	Mitigation Plan	Risk		Mitigation Status
			Instr. PDR Status	Observ PDR Status	
I-15	Optical Performance Requirements: Not meeting tight instrument wavefront requirement with 60-65% lightweighting of mirrors.	•Use experienced supplier. •Investigate relaxation of subsytem wavefront requirement •Investigate simplified optical designs	MEDIUM-LOW	LOW	•Goodrich selected as telescope supplier. •System wavefront requirement relaxed from lambda/18 to lambda/13.4. •Selected Cassegrain instead of TMA
I-16	Mass: Manage instrument mass to CSR prediction.	Apply appropriate design contingency at component level. Flow down mass allocation from instrument to subsystem level. Consider lower mass design alternatives.	LOW	LOW	Mass properties contingencies implemented which reflect LM design maturation experience. Mass allocation to subsystem level. Reduction in instrument aperture resulted in lower mass optical design.
I-17	Power: Manage instrument power to stay within Instrument to S/C IRD power allocations for different mission modes.	Apply appropriate design contingency at board or subsystem level. Consider lower power design alternatives.	LOW	LOW	Appropriate contingency assigned according to design maturity. Thermal lead working with electronics box designers to limit box radiator area and survival power. Lower survival power for smaller FPA.

OPDR Bus Risk Assessment (1 of 2)

| No.	Risk Item	Mitigation Plan	Risk	Mitigation Status
			PDR Status	
S/C - 1	Solar Torque Precession: -Ability to test Solar Torque Precession System	•Develop Detailed Models including secondary torque inputs •Parallel development of Models [USNO, NRL] •Perform Optical Properties Tests of materials •Additional margins for Precession adjustment •Add Backup Capability	MEDIUM	Optical Properties tests of candidate materials conducted at GSFC. USNO Developed Model Compares with NRL Model 50% Margin Included on Precession Adjustment Torque Rods [Nutation Control] available to augment Solar Torque
S/C - 2	Safe Hold Mode: Pointing of Instrument at Sun during Safe Modes	•Perform Analysis of Solar Input to Instrument Subsystem	None	Analysis performed indicates no damage to instrument if pointed at sun.
S/C - 3	Star Tracker Cover: Risk of Contamination At Launch	•Perform Contamination/Risk Analysis •Add covers if required.	MEDIUM - LOW	Contamination Analysis/Risk to be conducted post PDR.
S/C - 4	Impact of Antenna on Spin Rate	•Perform Analysis of Antenna Size/Location. •Deterimine effect of spin rate change on science data.	MEDIUM - LOW	Conducting Analysis of current design; will continue after PDR.
S/C - 5	Propellant Margins: Would prefer greater than 25% margin on propellants at PDR; currently have 20%.	Detailed Tracking of ACS/Other Manuevers. Evaluate margins on larger launch vehicle.	MEDIUM	20% currently exists. Larger Launch vehicle would allow greater than 25% margin.

| No.	Risk Item	Mitigation Plan	Risk	Mitigation Status
			PDR Status	
S/C - 6	Power Margins: Suffcient power margin exists but design will not allow for additional growth.	•Maintain Detailed Power Budgets. •Manage Power Growth by design.	MEDIUM - LOW	•Detailed power budgets currently tracked. •Listed by mission phase.
S/C - 7	Processor Throughput: FSC Processor performs both S/C and Instrument functions during Instrument Operations	•Determine Performance Margins as soon as possible. •Power both sides of FSC during operations if necessary.	MEDIUM	Instrument Software Modules being run on target processor (RH-3000) to gather metrics.
S/C - 8	Spacecraft Jitter: Jitter Directly effects science measurement; "Low Frequency" jitter worse than "High Frequency".	Eliminate all moving parts from System Design during Instrument operations. Maintain thermal stability during operations. (Eclipse N/A)	MEDIUM - LOW	Design does not include moving parts during operations. Electronics Configuration (power consumption) does not change during operations.
S/C - 9	Algorithm Definition: New algorithms required for FAME operation.	Early Documentation of Algorithms; Software performance of algorithms	MEDIUM - LOW	•Instrument Algorithm Working Group Established. •Preliminary Algorithm Description Document in process. •Joint effort with USNO/LM-ATC/NRL
S/C - 10	System Mass Margin: Have less than 20% mass margin at PDR.	Evaluate Program Impact to use Larger Launch Vehicle.	HIGH	Impact to use larger launch vehicle evaluated. -Allows larger RCS system/ no cost schedule impact. -Allows larger AKM/ no cost schedule impact. -Allows use of previous structural design; need to perform analysis; potential schedule impact but mitigation p
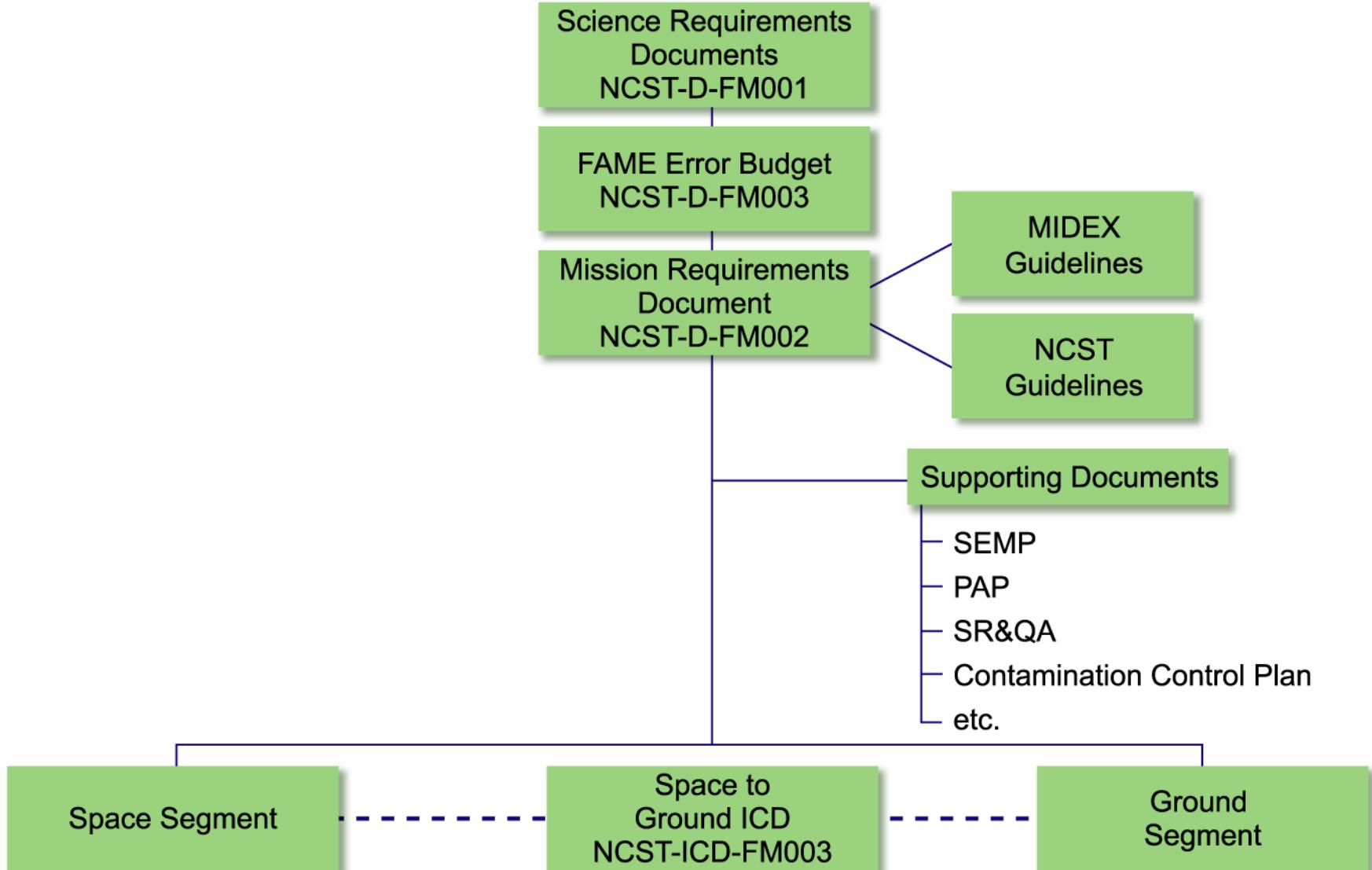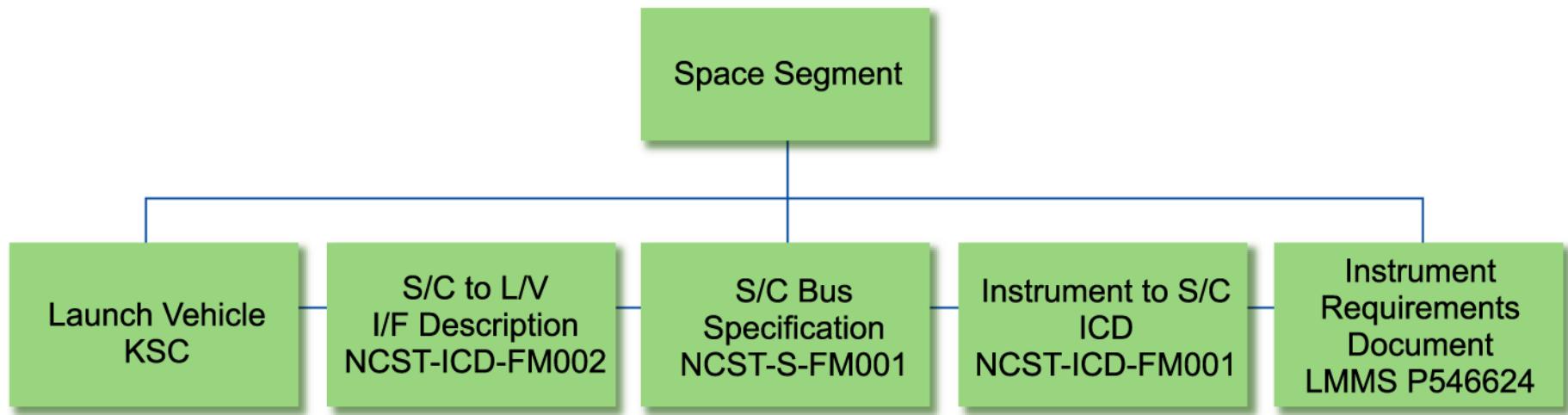
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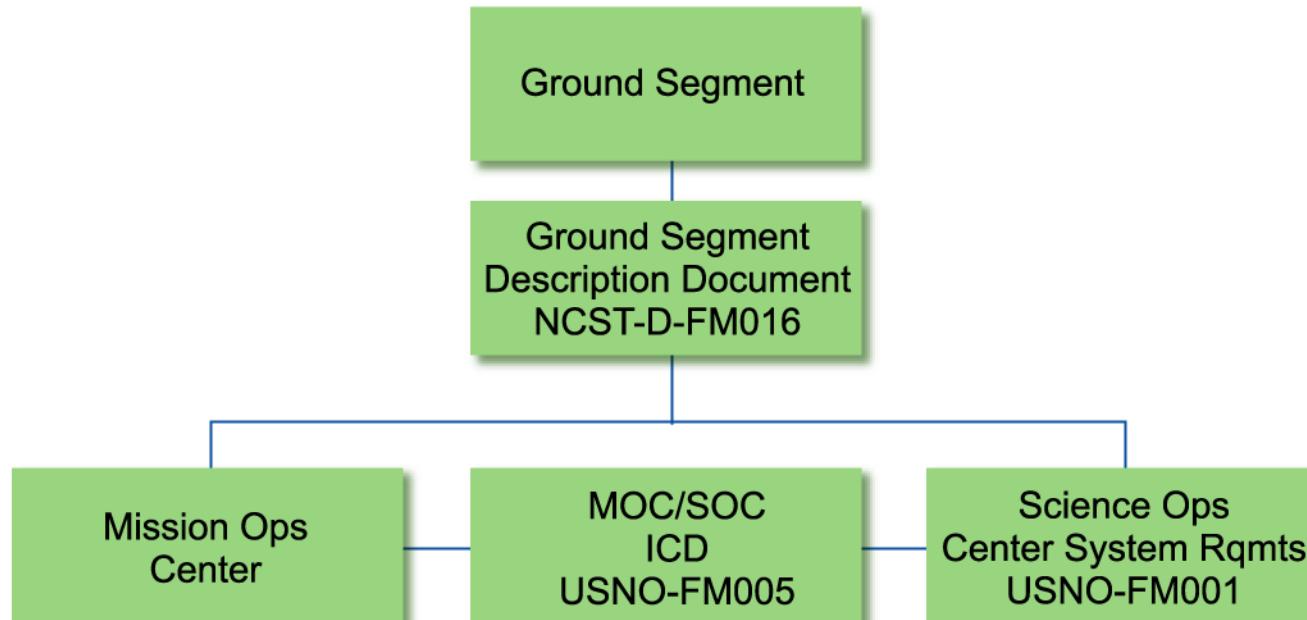
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Documentation Deliverables (1 of 3)

Number	Document Name	SRR	PDR	CDR	PER	PSR	FRR
NCST-D-FM001	Science Requirements Document	Final	Update				
NCST-D-FM002	Mission Requirements Document	Final	Update				
NCST-D-FM003	FAME Error Budget	Final	Final				
NCST-D-FM004	Systems Engineering Management Plan	Prel.	Final				
NCST-D-FM005	Product Assurance Plan	Prel.	Final				
NCST-D-FM006	SR&QA Plan	Prel.	Final				
NCST-D-FM007	Observatory Contamination Control Plan		Prel.	Final			
NCST-D-FM008	Configuration Management Plan	Prel.	Final				
NCST-D-FM009	FAME Safety Assessment Report (SAR)		Phase I	Phase II	Phase III		
NCST-D-FM010	System Safety Program Plan (SSPP)		Prel.	Final			
NCST-D-FM011	Failure Mode and Effects Analysis (FMEA)		Prel.	Final			
NCST-D-FM012	EEE Parts List		Initial				
NCST-D-FM013	Materials List		Initial				
NCST-D-FM014	Orbital Debris Report (CDR +60 Days)		Prel.	Final			
NCST-D-FM015	Space Segment Reliability Analysis		Prel.	Final			
NCST-D-FM016	Ground Segment Description Document		Prel.	Final			
NCST-D-FM017	Design, Loads, and Analysis Plan	Prel.	Final				
NCST-D-FM018	FAME EMI/EMC Control Plan						
NCST-D-FM019	FAME KSC Facility Safety Plan				Prel.	Final	
NCST-D-FM020	FAME Eastern Range Safety Plan Addendum				Prel.	Final	

Number	Document Name	SRR	PDR	CDR	PER	PSR	FRR
NCST-D-FM022	FAME Safety Verification Tracking Logs			Prel.			Final
NCST-D-FM023	FAME Field Procedure Guideline			Prel.	Final		
NSCT-ICD-FM001	Instrument to S/C ICD	Prel.	Final				
NCST-ICD-FM002	S/C to L/V Interface Description		Prel.	Final			
NCST-ICD-FM003	Space to Ground ICD		Prel.	Final			
NCST-ICD-FM005	FAME Spacecraft Controller (FSC) Hardware to Software ICD		Prel.	Final			
NCST-S-FM001	S/C Bus Design Specification	Prel.	Final				
NCST-S-FM002	Transponder Specification						
NCST-S-FM003	FAME Star Tracker Specification						
NCST-S-FM006	FAME Component Specification, Reaction Control System, Propellant Tank						
NCST-S-FM007	FAME Inertial Measurement Unit Specification						
NCST-S-FM008	FAME Spacecraft Controller Processor Module Specification						
NCST-S-FM009	Diplexer Specification						
NCST-SDP-FM001	Flight Software Development Plan		Prel.	Final			
NCST-SDP-FM002	Ground Software Development Plan		Prel.	Final			
NCST-SRS-FM001	Flight Software Requirements Document		Prel.	Final			
NCST-SRS-FM002	Ground Software Requirements Document		Prel.	Final			
NASA-IVV	Flight Software IV&V Project Plan						
NCST-TP-FM001	FAME System Integration & Test Plan		Prel.	Final			
USNO-FM001	SOC System Requirements		Prel.	Final			
USNO-FM002	SOC CONOPS		Prel.	Final			

Number	Document Name	SRR	PDR	CDR	PER	PSR	FRR
USNO-FM003	SOC S/W Development Plan		Prel.	Final			
USNO-FM004	SOC System Design		Prel.	Final			
USNO-FM005	MOC/SOC ICD		Prel.	Final			
USNO-FM006	Data Analysis Plan		Prel.	Final			
	Observatory Environmental Test Matrix			Final			
	Final B/C/D Technical Report						
	Final Phase E Technical Report						
	Flight Operations Plan				Prel.	Final	
	Ground Operations Procedures (30 days before operation as detailed in NCST-D-FM023, Field Procedure Guidelines)				Final		
P546624	Instrument Requirements Document	Prel.	Final				
P546614	Instrument Contamination Control Plan		Prel.	Final			
	Integration and Test Procedures			Final			
	Software User Guides				Prel.	Final	
	Verification Procedures			Final			

Schedule Ground Rules

- **5 Day Work Week With Holidays Off For All Activities Up to Shipment to Cape With The Following Exceptions:**

  - **Bus Bakeout and Observatory TVAC are 24/7 Activities**

  - **Weekends Are Available For Making Up Time on Critical Path Activities (Particularly Important During System Level I&T)**

- **6 Days/Week, 10 Hours/Day For Stand Alone Field Operations at KSC**

  - **08/07/04 to 10/18/04**

- **7 Day Work Week With 24 Hour Availability For Integrated Activities With the Launch Vehicle**

  - **T-11 Day Until Launch (10/30/04)**

FAME Schedule Summary

tivity ID	Activity Description	Start Type	Start	Finish
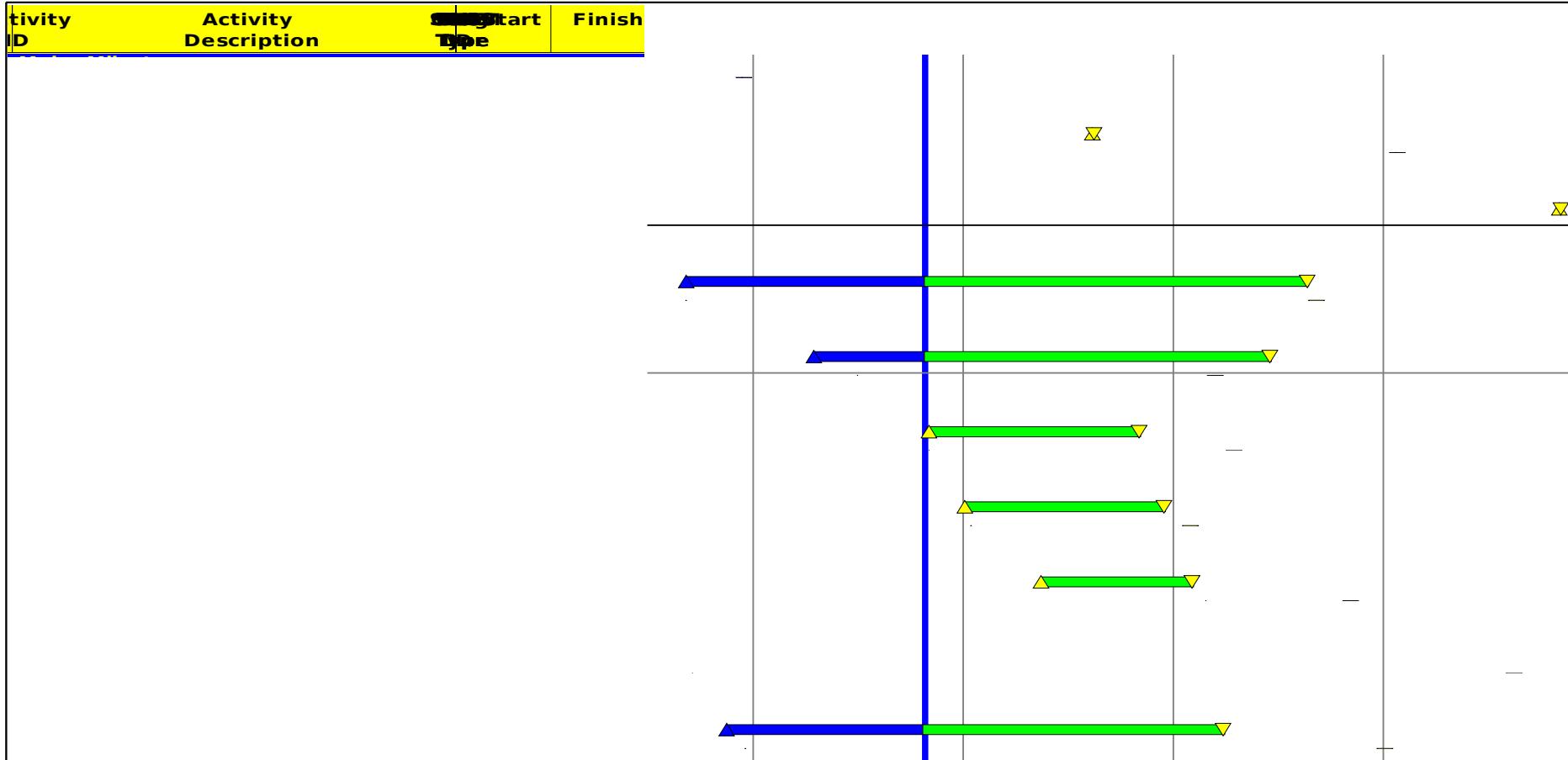
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Finish Date	28JAN05
Data Date	24OCT01
Run Date	24OCT02 09:0

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Early Bar
Progress Bar
Critical Activity

FAME   Sheet 1 of 3

**FAME Project
Summary Schedule
10/31/01**

Date	Revision	Checked	Approved

FAME Schedule Summary

tivity ID	Activity Description	Orig Type	Start	Finish

Sheet 2 of 3

FAME Schedule Summary

Sheet 3 of 3

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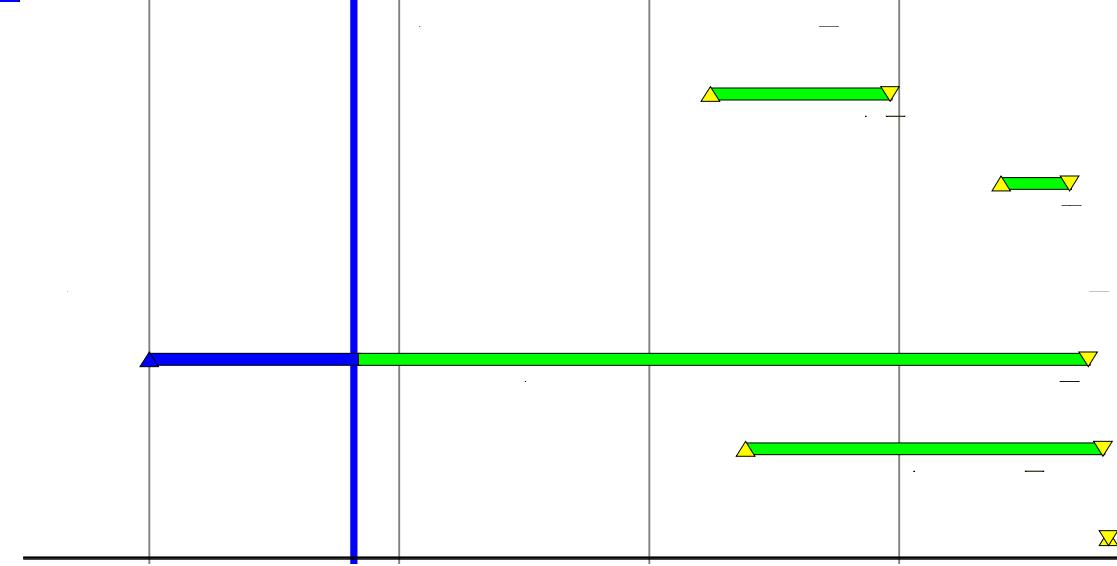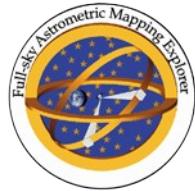
Schedule Highlights

- **Major Milestones:**
  - **PDR:** **10/30/01**
  - **CDR:** **08/13/02**
  - **Engineering Model TRR:** **02/21/03**
  - **Instrument Arrives at NRL:** **11/14/03**
  - **Flight Vehicle TRR:** **01/22/04**
  - **PSR:** **05/17/04**
  - **Observatory Arrival at KSC:** **09/03/04**
  - **Arrival at Pad:** **10/23/04**
  - **Launch:** **10/30/04**

- **Schedule Margin:**
  - **Program Has 70 Working Days (5 Days/Week) Schedule Slack Prior to Shipping to KSC**
  - **Program Has 14 More Days Schedule Slack Prior to Starting Integrated Activities With Launch Vehicle**

Schedule Tracking

- **Weekly Schedule Status**
  - **Tracks a Small Number of Key Subsystem Activities**
  - **Focused on a Rolling Two Week Window - Current & Next Week**
  - **Provides Method/Forum For Subsystem Leads and Program Manager to Work Issues in Near Real Time**
- **Monthly Schedule Updates**
  - **Subsystem Leads Submit Progress Updates For All Current Activities**
  - **Allows For Regular Critical Path Activity Monitoring**
  - **Float Analysis Identifies Activities Nearing Critical Path Status**
    - **Allows Program Manager to Recognize Current and Emerging Problems & Then Reassign Priorities and/or Resources**
- **Top Ten List**
  - **Continuous Tracking of the Top Ten Program Tasks With the Highest Schedule Risk**